حلول شيتات القياسات
الميكانيكية

Sheet 1 : static characteristics

Prob ①:- $A_1(Q_1) = 101.5$ L/min & $A(Q) = 100.4$ L/min

Req:- δA , δc =??

$$\delta A = A_1 - A = 1.1 \text{ L/min}$$

$$\delta_c = -\delta A = A - A_1 = -1.1 \text{ L/min}$$

Prob ②:- $A_1(V_1) = 109.5$ Volt & $\underbrace{A(V)}_{Req} = ??$ & $\delta A = -0.37$ Volt

$$A = A_1 - \delta A = 109.5 - (-0.37) = 109.87 \text{ Volt}$$

Prob ③:- $A_1(V_1) = 4.65$ m/s & $A(V) = 4.98$ m/s

Req:- ϵ_r ?!!

$$\epsilon_r = \frac{\delta A}{A} = \frac{A_1 - A}{A} = \frac{4.65 - 4.98}{4.98} = -0.066265$$

Prob ④:- $X_{min} = 5$ mmHg & $X_{Max} = 760$ mmHg & accuracy = ±1%

Req:- scale Range, span, Maximum static error.

scale Range = $X_{Max} = 760$ mmHg

scale span = $X_{max} - X_{min} = 755$ mmHg

static error $\begin{cases} \rightarrow \text{as a ratio of Range} \\ \rightarrow \text{as a ratio of span} \end{cases}$ but Range ≥ span

∴ Maxium static error is to be considered as a ratio of scale Range

$$\epsilon_s = \frac{\pm 1}{100} * 760 = \pm 7.6 \text{ mm Hg}$$

Prob 5 :- $d = 0.3\ mm$, sensitivity $= 3\ mm/C^\circ$

$\alpha_{Hg} = 0.181 * 10^{-3}\ /C^\circ$

Req :- bulb Volume $(V) = ??\ mm^3$

$$\Delta V = V\alpha\,\Delta T = \Delta h * A$$

$$\therefore V = \frac{\Delta h * A}{\alpha\,\Delta T} = \frac{3 * \frac{\pi}{4} * 0.3^2}{0.181 * 10^{-3} * 1} = 1171.59\ mm^3$$

Prob 6 :- Determine the linearity of a Potentiometer to obtain an error not to exceed 1 Part in 10000 .

$$\therefore e_l\,\% = \frac{(e_l)_{Max}}{r_o} * 100 = \frac{1}{10000} * 100 = 0.01\ \%$$

Prob 7 :- An instrument requires a current of 0.05 A to overcome initial friction and produce motion of the moving parts. Define the effect and the which produce it

Dead Zone :- هي أكبر قيمة تتغير في الدخل قبل أن يبدأ الجهاز في الإستجابة ويعطي قراءة .

The effect is the Dead Zone $= 0.05\ A$

Prob 8 :- Dead zone $= 0.125\%$ of span   Calibration : $800\ C^\circ \rightarrow 1800\ C^\circ$

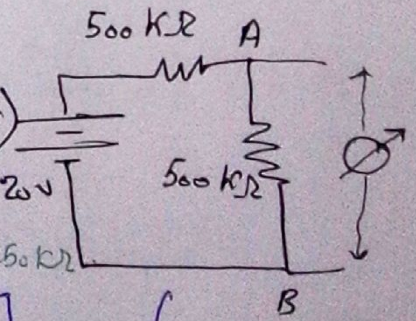
what temperature change must occur before it is detected?

$$\text{Dead Zone} = \frac{0.125}{1000} * (1800 - 800) = 1.25\ C^\circ$$

Prob 9 :- Voltmeter sensitivity $\} = 20\ k\Omega/V$

Req :- what is the true value Across A, B

what is the Reading of Voltmeter on the following rangs : 50, 15, 5 Volt)

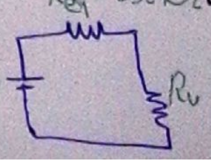


true Value $= 20V\,(500+500) * 500 = 10\ V$

$R_{eq} = 250\ k\Omega$

Rang	R_v	Reading
50	$\Rightarrow 1000\ k\Omega$	8 V
15	$\Rightarrow 300\ k\Omega$	5.45 V
5	$\Rightarrow 100\ k\Omega$	2.86 V

$$\text{Value} = \frac{10}{(R_{eq} + R_v)} * R_v$$



sheet 2

Prob ① flow meter :- accuracy ±0.75 % of scale reading above 20% of scale Reading

$\hookrightarrow 0 \rightarrow 100\ m^3/s$

what is the static error if the instrument indicate $80\ m^3/s$

The static error $\delta Q = \pm \frac{0.75}{100} * 100 = \pm 0.75\ m^3/s$

Prob ② $d = 0.1\,m$, $U = 1\ m/s$, $\frac{\delta d}{d} = \pm 1\%$, $\frac{\delta U}{U} = 3\%$

Req : Q & Q Range

$\therefore Q = AV = \frac{\pi d^2}{4} U = \pi * 0.1^2 * 1 = \frac{31.416}{4}$ L/s $= 7.854$

$\therefore \frac{\delta Q}{Q} = \left(2\frac{\delta d}{d} + \frac{\delta U}{U}\right) = \left(2 * \frac{1}{100} + \frac{3}{100}\right) = \pm\frac{5}{100}$

$\boxed{7.461 < Q < 8.247}$ L/S

$\therefore \delta Q = \pm\frac{1.5708}{4}$ L/S $= \pm 0.3927$ L/s

$\therefore Q$ Range : from $Q - \delta Q = \frac{31.416 - 1.5708}{4} = \frac{29.845}{4}$ L/S

to $Q + \delta Q = \frac{31.416 + 1.571}{4} = \frac{32.987}{4}$ L/S

Prob ③ :- $R_1 = 500\,\Omega \pm 1\%$, $R_2 = 615 \pm 1\%$, $R_3 = 100 \pm 0.5\%$

Req :- (a) R_4 & (b) δR_4 & (c) $\frac{\delta R_4}{R_4}$

$\therefore R_4 = \frac{R_1 R_2}{R_3} = \frac{500 * 615}{100} = 3075\ \Omega$

$\therefore \frac{\delta R_4}{R_4} = \pm\left[\frac{\delta R_1}{R_1} + \frac{\delta R_2}{R_2} + \frac{\delta R_3}{R_3}\right] = \pm\frac{2.5}{100} = \pm 2.5\%$

$\therefore \delta R_4 = 3075 * \frac{2.5}{100} = 76.875\ \Omega$

Prob (4) :- $R_1 = 200\,\Omega \pm 5\%$, $R_2 = 100\,\Omega \pm 5\%$, $R_3 = 50\,\Omega \pm 5\%$

Req : R_{eq}, δR_{eq}, $\frac{\delta R_{er}}{R_{er}}$ → (a) if R_1, R_2, R_3 Connected is series
→ (b) Connected in Parrallel

Case (1) :- R_1, R_2, R_3 Connected in series

$\therefore R_{eq} = R_1 + R_2 + R_3$

$= 200 + 100 + 50 = 350\,\Omega$

$$\frac{\delta R_{eq}}{R_{eq}} = \left[\frac{R_1}{R_T} \frac{\delta R_1}{R_1} + \frac{R_2}{R_T} \cdot \frac{\delta R_2}{R_2} + \frac{R_3}{R_T} \cdot \frac{\delta R_3}{R_3} \right]$$

$$= \left[\frac{200}{350} * 0.05 + \frac{100}{350} * 0.05 + \frac{50}{350} * 0.05 \right] = \pm 5\%$$

$\therefore \delta R_{eq} = 0.05 * 350 = 17.5\,\Omega$

حل آخر

$R_1 = 200 \pm 10\,\Omega$

$R_2 = 100 \pm 5\,\Omega$

$R_3 = 50 \pm 2.5\,\Omega$

$R_T = 350 \pm 17.5\,\Omega$

$\frac{\delta R_T}{R_T} = \frac{17.5}{350} = 5\%$

; 350 is the nominal value and 17.5 is the limiting error

Case (2) :- R_1, R_2, R_3 Connected Parallel

$$R_T = \frac{R_1 R_2 R_3}{R_1 R_2 + R_2 R_3 + R_1 R_3} = \frac{200 * 100 * 50}{\cancel{300 + 150 + 250}\ 3.5 * 10^4} = \frac{200}{7}\,\Omega$$

assume $R_1 R_2 R_3 = X$, $R_1 R_2 = a$, $R_2 R_3 = b$, $R_1 R_3 = c$, $a + b + c = Y$

$\therefore a = 2 * 10^4$, $\frac{\delta a}{a} = 10\%$, $\delta a = 2 * 10^3$

$\therefore b = 1 * 10^4$, $\frac{\delta b}{b} = 0.1$, $\delta b = 1 * 10^3$

$\therefore c = 5 * 10^3$ $\frac{\delta c}{c} = 0.1$, $\delta c = 500$

$\therefore Y = 3.5 * 10^4$, $\delta Y = \delta a + \delta b + \delta c = 3.5 * 10^3$, $\frac{\delta Y}{Y} = 10\%$

$\therefore X = 1 * 10^6$, $\frac{\delta X}{X} = \left(\frac{\delta R_1}{R_1} + \frac{\delta R_2}{R_2} + \frac{\delta R_3}{R_3} \right) = 15\%$, $\delta X = 15 * 10^4$

$$\therefore \frac{\delta R_T}{R_T} = \left(\frac{\delta X}{X} + \frac{\delta Y}{Y} \right) = 25\%$$

$\therefore \boxed{\delta R_T = \frac{50}{7}}$, $\boxed{R_T = \frac{200}{7}}$ $\boxed{\frac{\delta R_T}{R_T} = 25\%}$

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Prob 5 ; $S = \dfrac{3D^2 P}{16 t^2}$ (N/m^2) ; $D = 15$ mm ; $t = 0.2$ mm ;

; $P = 8*10^5$ N/m^2 ;

$\dfrac{\delta D}{D} = \pm 1\%$, $\dfrac{\delta t}{t} = 3\%$,

Req:- (S) ; (δ S)

$$S = \frac{3*(0.015)^2 * 8*10^5}{16*(0.2*10^{-3})^2} = 843.75*10^6 \ (N/m^2)$$

$$\frac{\delta S}{S} = \pm\left[2\frac{\delta D}{D} + \frac{\delta P}{P} + 2\frac{\delta t}{t}\right] = \pm\left[\frac{2*1}{100} + 0 + \frac{2*3}{100}\right] = \pm 8\%$$

$$\therefore \delta S = \frac{8}{100} * 843.75*10^6 = 67.5*10^6 \ (N/m^2)$$

Prob 11-b $P = \dfrac{2\pi * 9.81 \, FLR}{t*10^6}$, $F = 4.58 \pm 0.02$ kg , $L = 397 \pm 1.3$ mm

$R = 1202 \pm 1$ rpm , $t = 60 \pm 0.5$ S

Req:- P ; δP ?!!

$$P = \frac{2\pi * 9.81 * 4.58 * 397 * 1202}{60*10^6} = 2.2452 \ KW$$

$$\frac{\delta P}{P} = \left[\frac{\delta F}{F} + \frac{\delta L}{L} + \frac{\delta R}{R} + \frac{\delta t}{t}\right]$$

$$\frac{\delta P}{2.2452} = \pm\left[\frac{0.02}{4.58} + \frac{1.3}{397} + \frac{1}{1202} + \frac{0.5}{60}\right] \simeq \pm 0.0168$$

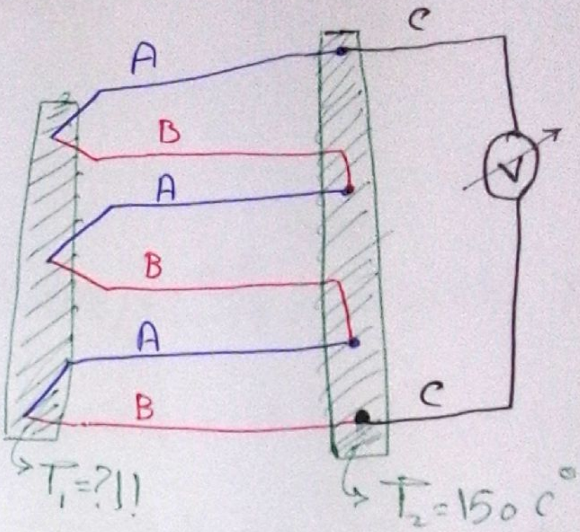
$$\delta P = 2.2452 * 0.0168 \simeq \pm 0.0377 \ KW \simeq \pm 37.7 \ W$$

sheet: 3 "Temperture"

Prob ①:- Copper - Constantan Thermo Pile

$T_2 = 150\ C^\circ$

$V_T = 3.3\ mV$



Tem (C°)	100	200	250
Volt (mV)	4.22	9.23	11.95

Req:- $T_1 = ?!!$

$$emf = \frac{V_T}{3} + V_{(150)} = \frac{3.3}{3} + \frac{4.22 + 9.23}{2} = 7.825\ mV$$

$$\therefore T_1 = 100 + \left(\frac{9.23 - 4.22}{7.825 - 4.22}\right)^{-1} * (200 - 100)$$

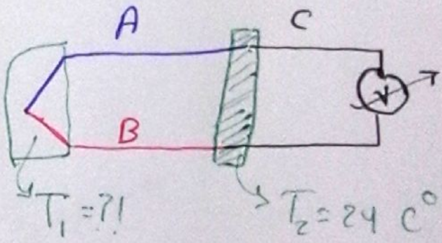
$100\ C^\circ$	$4.22\ mV$
$T_1\ C^\circ$	$7.825\ mV$
$200\ C^\circ$	$9.23\ mV$

$$= 100 + 100 * \frac{3.605}{5.01}$$

$$= 171.956\ C^\circ$$

Prob 6:- a- chromel-alumel thermo couple

$V_T = 25.76\ mV$, $T_2 = 24\ C^\circ$



Tem (C°)	20	24	28	....	680	688	693
Volt (mV)	0.8	0.95	1.12	....	26.25	26.72	29.04

$$V_{T_1} - V_{T_2} = V_{I_1} - V_{I_2}$$

$$25.76 = V_{I_1} - 0.95$$

$$V_{I_1} = 26.71\ mV$$

$$\therefore T_1 \simeq 688\ C^\circ$$

interpolation

V	T
26.25	680
26.71	T_1
26.72	688

$$\therefore T_1 = 688 - 0.01 * \frac{8}{0.47}$$

$$= 688 - \frac{8}{47}$$

$$= 687.83\ C^\circ$$

Prob 5A :- $T_1 = 1065\ C^\circ$, $\mathcal{E}_1 = 0.82$, $\mathcal{E}_2 = 0.75$

$\because q/A = \sigma \mathcal{E} T^4$.

$\therefore \cancel{\sigma} \mathcal{E}_1 T_1^4 = \cancel{\sigma} \mathcal{E}_2 T_2^4$

$$T_2 = T_1 * \left(\frac{\mathcal{E}_1}{\mathcal{E}_2}\right)^{0.25} = (1065+273) * \left(\frac{0.82}{0.75}\right)^{0.25} = 1368.18\ K^\circ$$

$$\mathcal{E}_0 = T_1 - T_2 = A_1 - A = 1065+273 - 1368.18 = -30.18\ K^\circ$$

Prob 5 B :- $T_t = 1\ C^\circ = 274\ K^\circ$, $T_w = -10\ C^\circ = 263\ K$, $h = 10\ w/m^2.C^\circ$

$\mathcal{E}_g = 0.9$, $\sigma = 57.2 * 10^{-9}\ w/m^2.K^4$

for steady state Condition for the thermometer.

$\therefore Q_{absorbed} = Q_{transmitted\ by\ radiation}$

$$h \cancel{A} (T_g - T_t) = \mathcal{E} \sigma * \cancel{A} (T_t^4 - T_w^4)$$

$$10 (T_g - 274) = 0.9 * 57.2 * 10^{-9} (274^4 - 263^4)$$

The glass Temperture $\therefore T_g = 278.4\ K^\circ = 5.4\ C^\circ$

Then the air Temperture is $5.4\ C^\circ$

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Sheet 4 : Pressure

Q1 : $d_1 = 5$ mm , $d_2 = 150$ mm , $\rho_m = 13600$ kg/m^3 ,

$\Delta P = 100 \frac{KN}{m^2}$

Req :- $\grave{h}$

$\because P_1 - P_2 = g h(\rho_m - \rho_f) = \rho_m g \grave{h}(1 + \frac{a}{A})$

$100 * 10^3 = 13600 * 9.81 * \grave{h}\left(1 + \left(\frac{5}{150}\right)^2\right)$

$\therefore \grave{h} = 0.7487$ m $= 748.7$ mm

Prob 2 :- $d = 2$ mm , $D = 20$ mm , $(S.G)_f = 0.8$, $d = 5$ mm , $\Delta P = 1$ mmwt

$\because \Delta P = \rho_f g d\left(\frac{A_1}{A_2} + \sin\alpha\right) = \rho_w g h_w$

$SG = \frac{\rho_f}{\rho_w}$ $\longleftarrow$ $0.8 * 5 * 10^{-3}\left(\left(\frac{2}{20}\right)^2 + \sin\alpha\right) = 1 * 10^{-3}$

$\therefore \sin\alpha = 0.24$

$\therefore \alpha = \sin^{-1} 0.24 = 13^\circ\ 53'\ 12''$

Prob 3 :- $D = 30$ mm , $d = 1$ mm , $\Delta P = 1$ mHg

Req :- $(\grave{h} - h)\rho g$, $\grave{h}$, $\frac{\grave{h} - h}{h}$

$\because \Delta P = \rho g h = \rho g \grave{h}\left(1 + \frac{a}{A}\right)$

$h = \grave{h}\left(1 + \frac{a}{A}\right) \longrightarrow \grave{h} = \frac{h}{\left(1 + \frac{a}{A}\right)} = \frac{1}{\left(1 + \left(\frac{1}{30}\right)^2\right)} = 0.9989$ m

$\mathcal{E}_r = \frac{\grave{h} - h}{h} * 100 = -0.111\ \%$

$\mathcal{E}_o = \grave{h} - h = -1.11$ mm Hg $= -1.11 * 9.81 * 13.6 = -148.1$ Pa

$\boxed{|\mathcal{E}_o| = 1.11 \text{ mmHg} = 148.1 \text{ Pa}}$

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Prob 4 :- $D = 20\ mm$, $d = 4\ mm$, $d = 1cm$, $\Delta P = 1mm$

Req :- $\alpha = ??$

$\because \Delta P = \rho g d \left(\frac{a}{A} + \sin\alpha\right) = \rho g h$

$1 \times 10^{-2} \left(\left(\frac{4}{20}\right)^2 + \sin\alpha\right) = 1 \times 10^{-3}$

$\sin\alpha = 0.1 - 0.04 = 0.06$

$\therefore \alpha = \sin^{-1} 0.06 = 3.4398^\circ$

Prob 5 :- $D = 30\ mm$, $d = 5\ mm$, $\Delta P = 1\ bar$,

Req :- $h' = ??$

$\because \Delta P = \rho g h' \left(\frac{a}{A} + 1\right)$

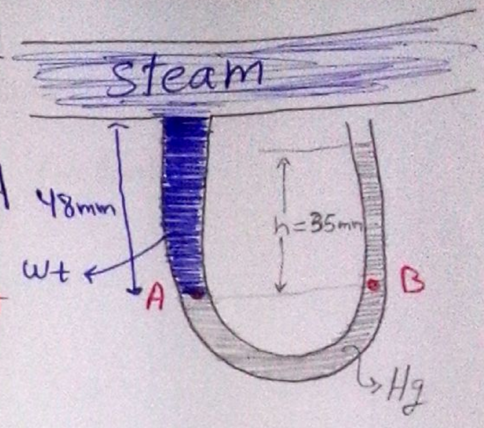
$$\therefore h' = \frac{1 \times 10^5}{9.81 \times 13600 \times \left(1 + \left(\frac{5}{30}\right)^2\right)} = 0.7293\ m = 729.3\ mm$$

the sentivity $= \frac{\text{out Put}}{\text{in Put}}$ → for well manometer the out Put is h' and for the U-tube manometer the out Put is h for the same in Put (ΔP)

since $h = h'\left(1 + \frac{a}{A}\right) \rightarrow h > h'$

$\therefore$ the sentivity of awell manometer is less than the sentivity of simple U-tube manometer.

Prob 6:- $h = 35$ mm Hg , $P_{atm} = 762.1$ mm Hg



Req: (1) $P_{abs\ (steam)}$

(2) $\varepsilon_r \%$ if condensed water is not taken into account

$$P_A = P_B$$

$$P_{steam} + \rho_w g H = P_{atm} + (\rho g h)_{mercury}$$

$$P_{stam} = 9.81 * \left((35 + 762.1) * 10^{-3} * 13600 - 48 * 10^{3} * 10^{-3} \right)$$

$$= 105.875 \text{ KPa}$$

$$P_{(steam)_{error}} = P_{atm} + \rho g h_{(mercury)} = 9.81 * 797.1 * 13.6 = 106.346 \text{ KPa}$$

$$\varepsilon_{error} \% = \frac{P_{error} - P_{true}}{P_{true}} * 100 = \frac{106.346 - 105.875}{105.875} * 100$$

$$\varepsilon_r \% = 0.44475 \%$$

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sheet 5: flow rate

Prob ① $D_i = 200$ mm , $d = 100$ mm , " Venturi meter " , $h = 250$ mm

$C_d = 0.98$, $\rho_f = 1000$ kg/m^3 (water)

Req:- Q =?!

$$Q = \frac{C_d A_1}{\sqrt{m^2-1}} \sqrt{2gh\left(\frac{\rho_m}{\rho_f}-1\right)}$$

$$= \frac{0.98 * \pi * 0.1^2}{\sqrt{\left(\frac{200}{100}\right)^4-1}} * \sqrt{2*9.81*0.25*(13.6-1)}$$

$= 62.5$ L/S

$Q = \cancel{0.13974}$ m^3/s ~~= 139.74 L/s~~

Prob ② $\rho_{oil} = 800$ kg/m^3 , $\rho_{mercury} = 13600$, ρ_{air} is negligible

Req :- ε_r %

Case ① oil :- $\Delta P_1 = \rho g h(\rho_m - \rho_f) = gh(13600-800)$

~~true~~ ~~true~~ ~~error~~ true

Case ② air :- $\Delta P_2 = gh(\rho_m - \rho_{air}) = gh(13600)$

~~error~~ ~~true~~ error

$$\varepsilon_r \% = \frac{P_{error} - P_{true}}{P_{true}} * 100 = \cancel{\frac{gh(13600) - gh(13600-800)}{gh(13600-800)} * 100} = \cancel{\frac{800}{128}} =$$

As it was originally calibrated to measure Air Pressure then the true indication will be in case of ~~water~~ oil

$$\therefore \cancel{\varepsilon_r \%} = \frac{\cancel{gh(13600-800) - gh(13600)}}{gh(13600)} * 100 = -5.88\ \%$$

$$\cancel{|\varepsilon_r \%| = \frac{100}{17} \% = 5.88\ \%}$$

$\varepsilon_r = 6.25\ \%$

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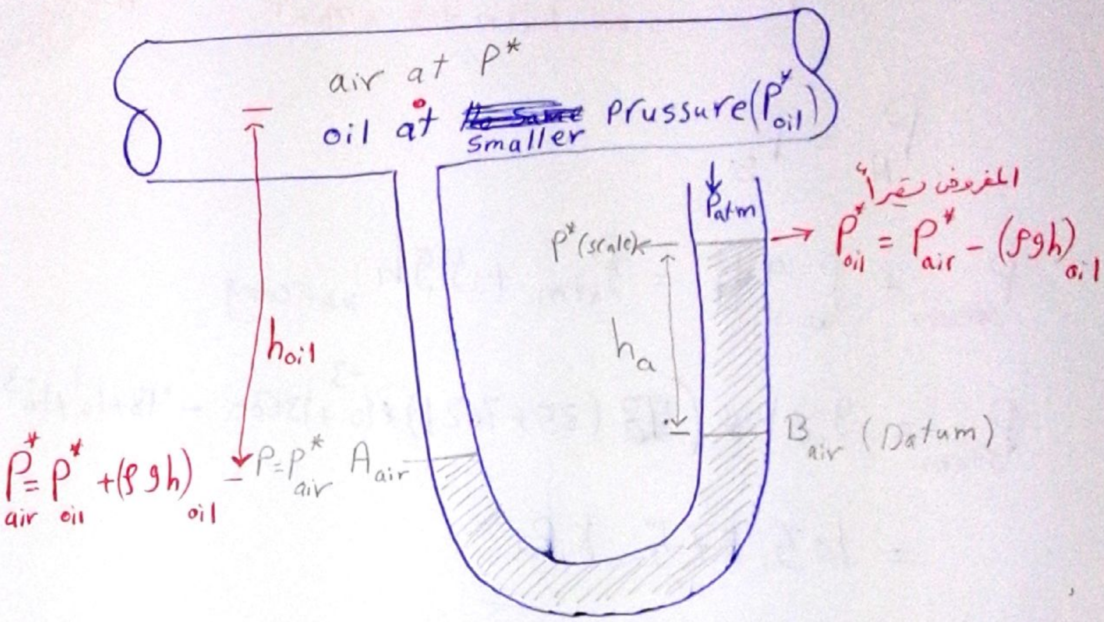
توضيح لمسألة ②



$$\therefore \delta P = P^*_{air} - P^*_{oil} = (\rho g h)_{oil}$$

Subin

$$\varepsilon_r\% = \frac{\delta P}{P^*_{oil}} = \frac{(\rho g h)_{oil}}{P^*_{oil}} \times 100$$

$$= \frac{800 \cancel{gh}}{(13600-800)\cancel{gh}} \times 100 = 6.25\%$$

3- $P_1 = 200\ KN/m^2$, $T_1 = 300\ C^\circ$

$P_2 = 150 + 100\ KN/m^2$, $T_2 = 200\ C^\circ$. $\frac{PV}{T} = Const$

Req:- Correction factor =??

$$V_1 = \frac{1}{\sqrt{m^2-1}} \sqrt{2gH}$$

$$Q_1 = \frac{Cd\ A_1}{\sqrt{m^2-1}} \sqrt{2gH\left(\frac{\rho_m}{\rho_f}-1\right)} \rightarrow ① \quad ; \rho_{f_1} = \frac{P_1}{RT_1} = \frac{200*10^3}{287*573} = 1.216\ \frac{kg}{m^3}$$

$$Q_2 = \frac{Cd\ A_1}{\sqrt{m^2-1}} \sqrt{2gH\left(\frac{\rho_m}{\rho_f}-1\right)} \rightarrow ② \quad \rho_{f_2} = \frac{P_2}{RT_2} = \frac{250*10^3}{287*473} = 1.8416\ \frac{kg}{m^3}$$

$$\therefore \text{Correction factor} = \frac{Q_2}{Q_1} = \sqrt{\frac{\left(\frac{\rho_m}{\rho_f}-1\right)_2}{\left(\frac{\rho_m}{\rho_f}-1\right)_1}} = 0.81262$$

Prob 4 :- orifice ; $D = 50mm$, $d = 30mm$, $R_e = \frac{vd}{\nu} = 10^5$, $Cd = 0.61$

$\rho = 1000\ kg/m^3$, $\nu = 10^{-6}\ m^2/s$

Req:- $V_{2\ orifice}$ =?! , ΔP =??

$$\Delta P = \rho_f g h\left(\frac{\rho_m}{\rho_f}-1\right)$$

$$V_1 = \frac{Cd}{\sqrt{m^2-1}} \sqrt{2gh\left(\frac{\rho_m}{\rho_f}-1\right)} = \frac{Re * \nu}{D} = \frac{10^{-6} * 10^5}{0.05} = 2\ m/s$$

$$\Delta P = \rho_f * gh\left(\frac{\rho_m}{\rho_f}-1\right) = \frac{\left(\frac{V_1}{Cd}\right)^2 * (m^2-1)}{2} * \rho_f$$

$$\Delta P = \frac{\left(\frac{2}{0.61}\right)^2 * \left(\left(\frac{5}{3}\right)^4 - 1\right)}{2} * 1000 = 36.1\ KPa$$

$$V_2 = V_1 * \left(\frac{D}{d}\right)^2 = mV_1 = 2 * \frac{5}{3} = 3.33\ m/s$$

Prob 5 :- $\rho_{air} = 1.2$ kg/m³ , $V = 20$ m/s , $D = 100$ mm , $d = 80$ mm

$C_d = 0.8$,

Req : h (wt) = ?!

$$\because V_1 = \frac{C_d}{\sqrt{m^2 - 1}} * \sqrt{2gh\left(\frac{\rho_w}{\rho_{air}} - 1\right)}$$

$$20 = \frac{0.8}{\sqrt{(1.25)^4 - 1}} * \sqrt{2 \times 9.81 \times h\left(\frac{1000}{1.2} - 1\right)}$$

$$\therefore h = 0.0552 \text{ m} = 55.2 \text{ mm}$$

Prob 6 :- $\rho_{air} = 1.22$ kg/m³ , $C.F = 0.98$, $h = 80$ mm

Req :- V = ?!

$$V = \sqrt{2gh \frac{\rho_w}{\rho_{air}}} * C.f$$

$$= \sqrt{2 \times 9.81 \times \frac{1000}{1.22} \times 0.08} * 0.98$$

$$V = 35.15 \text{ m/s}$$

Prob 7 :- $\Delta P = \rho g h = 100$ mm wt , $T = 27$ C° , $P_a = 10$ KN/m²

$P_{atm} = 760$ mm Hg , $R = 287$ J/kg.K , $S.G_{Hg} = 13.6$

$C.F = 0.98$ Req " the mean velocity "

$$\Delta P = P_b - P_a = P_b - 10 = \frac{100 * 9.81 * 10^3}{10^3 \times 10^3} = 0.981 \text{ KN/m}^2$$

$$\therefore P_b = 10.981 \text{ KN/m}^2$$

$$P_{atm} = \frac{760 * 9.81 * 13.6}{10^3} = 101.4 \text{ KN/m}^2$$

$$C = \sqrt{KRT} = \sqrt{1.4 \times 287 \times 300} = 347.2$$

$$\frac{V_A^2}{2} = \left(\frac{C^2}{K-1}\right)\left[\left(\frac{P_b + P_{atm}}{P_a + P_{atm}}\right)^{\frac{K-1}{K}} - 1\right]$$

$$\longrightarrow V_A = 38.88 * C_f = 38.1 \text{ m/s}$$